WILLIAMS (J. W)

Contributions to the Normal and Pathological Histology of the Fallopian Tubes.

BY

J. WHITRIDGE WILLIAMS, M.D.,

ASSISTANT IN GYNECOLOGY, JOHNS HOPKINS HOSPITAL, BALTIMORE.

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CONTRIBUTIONS TO THE NORMAL AND PATHOLOGICAL HISTOLOGY OF THE FALLOPIAN TUBES.

By J. Whitridge Williams, M.D.,
ASSISTANT IN GYNECOLOGY, JOHNS HOPKINS HOSPITAL, BALTIMORE.

For convenience of description I will divide the tube into three portions (Henle[1]): The isthmus, or the straight, narrow portion extending directly outward from the uterus; the ampulla, or the enlarged curved lateral part of the tube; and the infundibulum, or the fimbriated end of the tube. The isthmus is usually about 2 to 3 mm. in diameter, and the ampulla 6 to 10 mm. or more.

Roughly speaking, the tube may be said to consist of three coats: the serous (or, more properly speaking, the subserous), the muscular, and the mucous coats. Of these, the muscular and mucous coats are by far the most important.

The Serous Coat.—As the tube lies within the folds of the broad ligament at its upper margin, it is consequently almost entirely covered by peritoneum, except below where the two layers of the broad ligament converge and the tissues of the tube and broad ligament become continuous. Beneath the peritoneal covering is a thicker or thinner layer of connective tissue, the subserous coat. This layer is most rich in bloodvessels, and in its inferior portion—that is, the part not covered by peritoneum—run most of the large vessels that supply the tube.

The Muscular Coat.—As the uterus and tubes were originally the same canal—Müller's ducts—and as in adult life they are continuous, it would appear only natural to suppose that their muscle layers would be continuous, and that the tube, like the uterus, would contain three distinct layers of non-striated muscle, as is really the case. This fact was known to Henle,[2] whose description of the tube is certainly far superior to any yet written; but it has apparently been lost sight of by all the later writers on the subject, such as Martin,[3] Orthmann and Coe,[4] for they mention only two coats. The greater part of the thickness of the tube is due to its muscular layer, which can only be studied properly in serial sections of the same tube, for the arrangement differs considerably in different tubes and even in different parts of the same tube.

[1] Henle: Handbuch der Anatomie, Bd. 2, p. 485. [2] Ibid.
[3] Martin, A.: Handbuch der Frauenkrankheiten, 2 Auf., p. 378.
[4] Coe, H. C.: "Anatomy of the Female Pelvic Organs," Mann's System of Gynecology, vol. i. p. 161.

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The greater part of the muscular wall consists of a thick band of circular fibres which is usually quite distinct, except at the lateral end of the tube, where it fuses with the other layers and forms an irregular meshwork of muscle fibres, with the fibres running in all directions.

Outside of this comes a thinner layer of longitudinal muscle, which is also very distinct; and upon this follows the subserous connective tissue.

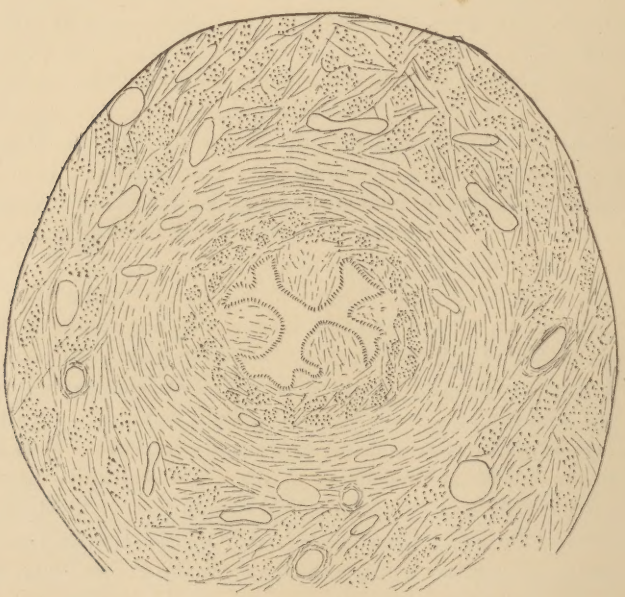
These are the two layers usually described by writers upon the subject, for they are readily seen on section from any part of the tube, except near the fimbriated extremity, where all the layers fuse together.

In some cases, however, the two layers become so blended throughout the entire length of the tube that it is impossible to separate them. (Fig. 4.)

These two layers correspond to the outer and middle coats of the uterus, and constitute almost the entire thickness of the wall of the tube.

Beside these two layers there is a third, corresponding to the third or

FIG. 1.



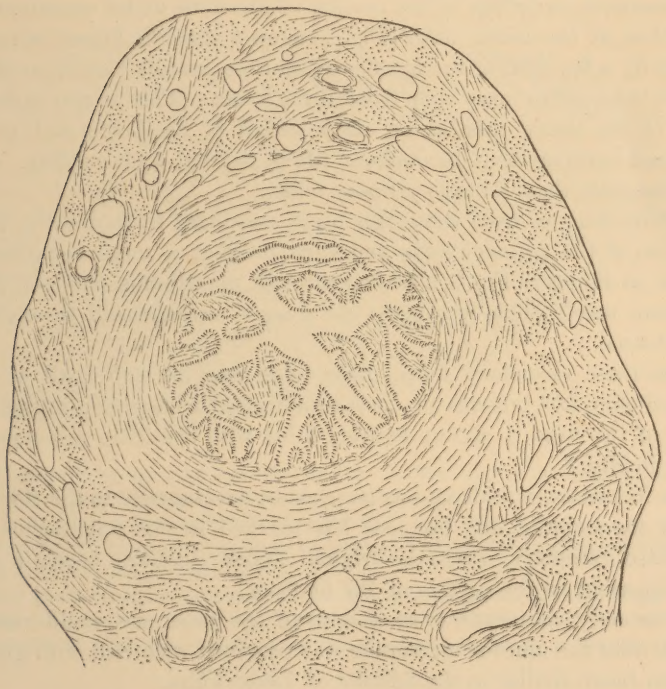
Cross-section of tube at cornu uteri, showing the four primary folds of the mucous membrane and the three layers of muscle forming the tube wall.

inner muscular coat of the uterus. On cutting sections of the tube just at the cornu uteri (Fig. 1) one sees, just within the circular layer, a well-marked but thin layer of longitudinal muscular fibres. This can be traced as a distinct layer for some little distance, but it gradually

becomes thinner and thinner, and, fusing with the circular coat, finally disappears.

Fig. 2 represents a section from the same tube about one inch nearer the fimbriated extremity than Fig. 1; and even at this distance from the uterus, the inner longitudinal layer has completely disappeared. It is apparently due to this fact that it is not mentioned by most writers, for sections from the middle portion of the tube show no trace of it.

FIG. 2.



Cross-section of the same tube at isthmus, one inch from Fig. 1, showing a more complicated arrangement of the mucous membrane and the disappearance of the inner longitudinal muscular layer.

THE MUCOUS MEMBRANE.—The most important and characteristic portion of the tube is the mucous membrane. Its arrangement is most remarkable, and in none of the English works is any adequate idea given of its complexity. The figure from Luschka,[1] which is usually given in the text-books, cannot pretend to represent a section from any part of the tube with any degree of accuracy.

[1] Luschka: Anatomie.

It is only by the study of serial sections that the true arrangement of the mucous membrane can be appreciated, for in no other way can one follow the wonderful changes from the simple, irregular canal at the uterine end of the tube to the wonderfully complicated structure at the ampulla.

Like all mucous membranes, that of the tube has its epithelial lining, its membrana propria, and its connective-tissue framework into which muscle fibres frequently penetrate.

The mucous membrane is arranged in longitudinal folds, which vary in appearance according to the portion of the tube under examination.

Sections at the cornu uteri (Fig. 1) show a star-like lumen, which is formed by a few folds of the mucous membrane, usually four in number, though the number may vary from three to six. This is the arrangement of the entire tube at an early period of fœtal life, and is the permanent arrangement throughout life in the bat and monkey. We may designate these folds as primary folds.

A short distance from the cornu uteri, secondary folds develop from the sides of the primary folds and thus produce a more complicated picture, as shown in Fig. 2, a section through the isthmus, one inch from the cornu uteri. This represents the general arrangement throughout the isthmus.

From these secondary folds, other folds may develop until at last each primary fold presents the most complicated appearance, so that the lumen of the tube is almost entirely filled with dendritic processes, as shown in Fig. 3.

This formation of folds attains its greatest development in the thickest part of the ampulla, and becomes less marked as one approaches the fimbriated extremity, where the original folded condition becomes once more apparent on the surface of the fimbriæ.

If one only examined cross-sections of the tube, one could readily suppose that the mucous membrane was provided with villi with glands between them, similar to the follicles of Lieberkühn.

Longitudinal sections, however, show that these processes are not villi at all, but simply cross-sections of longitudinal folds, which increase in number as one approaches the fimbriated extremity.

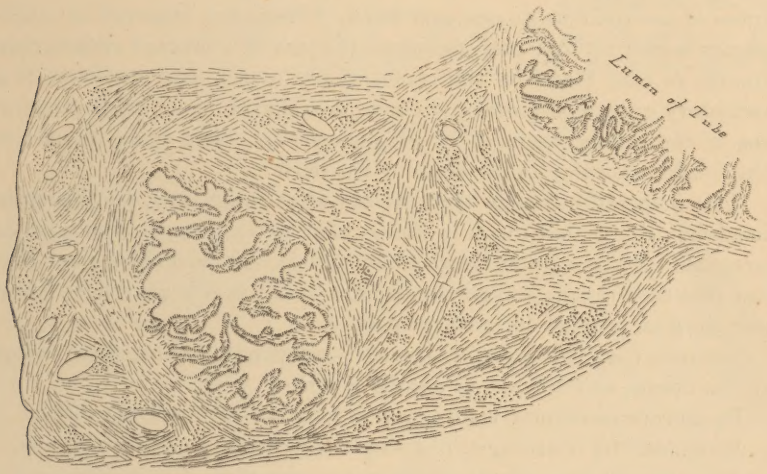
These folds are composed mostly of connective tissue, though they may contain a considerable amount of muscular tissue. The larger folds contain bloodvessels of considerable size and frequently large empty spaces corresponding to lymph-vessels.

The entire lumen of the tube is covered by a single layer of high columnar ciliated epithelium, under which comes an imperfectly developed propria.

All the cells are ciliated, and cilia can be seen in motion several hours after death; they are frequently as long or longer than the cells them-

selves. My statement that the epithelium is disposed in a single layer is supported by the statements of Henle,[1] Frommel,[2] and Orthmann.[3] On the other hand, Hennig[4] and others state that it is composed of several layers of cells; this statement was evidently made on the strength of observations made on sections which had been cut obliquely; for in that case one might readily suppose that the epithelium was composed of several layers.

FIG. 4



Cross-section of the same tube through the thickest part of the ampulla, one inch from Fig. 2, showing the extremely complicated arrangement of the mucous membrane and the two layers of muscle composing the wall.

These three sections are from a tube which was obtained at the autopsy of a nineteen-year-old virgin dead of typhoid fever.

They are all drawn under the same power of a Winckel microscope with a Zeiss camera lucida, and so represent with tolerable accuracy the absolute increase in the size and complexity of arrangement of the tube from its uterine extremity to the ampulla.

The statements of Hennig,[5] Bland Sutton[6] and others that the tube contains glands is also based upon false observations, as was conclusively

[1] Handbuch der Anatomie.

[2] Frommel: "Beiträge zur Histologie des Eileiters," Verhandlungen der Deutsch. Gesellschaft f. Gynäkologie, 1886, p. 95.

[3] Orthmann: "Beiträge zur normalen Histologie und zur Pathologie der Tuben," Virchow's Archiv, Bd. cviii. p. 165.

[4] Hennig: Katarrh der weiblichen Genitalien.

[5] Hennig: "Ueber die Blindgänge der Eileiter," Arch. f. Gyn., Bd. xiii. p. 156.

[6] Sutton: "Glands of the Fallopian Tube and their Function," Trans. of the London Obstetrical Society, 1888, vol. ii.

*

shown by Frommel,[1] who, after tying both ends of the tube, injected it with Flemming's solution, and when it was hardened, cut sections. "The effect was that all the folds which were in contact were separated from each other, and the rounded lumen of the tube was lined by branching, tree-like processes, but no trace of glands could be found." The blood-supply of the tube is most abundant, especially on its lower margin, where bloodvessels, sometimes three to four mm. in diameter, are found.

An interesting condition which I have observed in the arteries of the tubes of multiparous women and which I have not observed in nulliparous women, is that they are often the seat of a marked endarteritis, similar to that found in the vessels of the uterus and attributed to a secondary growth of connective tissue, consequent upon the increase in size of the vessels produced by pregnancy—its object being to narrow the lumen according to the needs of the parts.

This is the only change that persists after pregnancy, for Thomson[2] has lately shown that the only change that takes place in the tubes of pregnant rabbits is an increase of the muscle cells to double their size, but that they return to their normal size within twelve days after labor, and show no trace of the past pregnancy.

The tube has three layers of muscle, corresponding to the three layers in the uterus, and not two, as usually stated.

Its mucous membrane is arranged in longitudinal folds, not villi.

Its epithelium is arranged in a single layer and contains no glands.

The arteries of parous women frequently show marked endarteritis.

Diverticula of the Tube.—In connection with the normal anatomy of the tube, I desire to call attention to an abnormality in its development which may bear a causal relation to the production of extra-uterine pregnancy. I refer to diverticula extending from the lumen into the wall of the tube, reaching almost to its peritoneal covering. They are lined by the typical single layer of ciliated epithelium, and correspond in all respects to the structure of the normal lumen of the tube.

They should not be confounded with the so-called accessory ostia of the tube; for, unlike them, they do not open on the outer surface of the tube, and, on simple inspection, give no evidence of their existence.

I have observed this anomaly on two occasions, one as follows:

The specimen was obtained from a laparotomy performed by Dr. Kelly for a papillomatous cyst of the left ovary and a small corpus

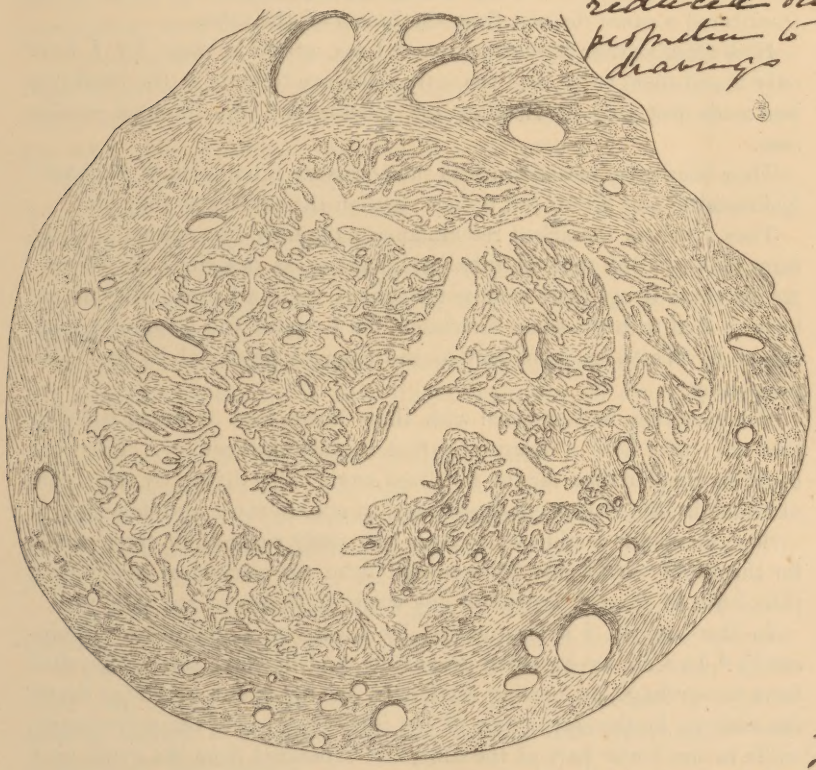
[1] Loc. cit.

[2] Thomson: "Ueber Veraenderungen der Tuben und Ovarien in der Schwangerschaft und im Puerperium," Zeitschrift f. Gyn., Bd. xviii. p. 273.

luteum cyst of the right ovary. Both Fallopian tubes appeared perfectly normal and it was only on cutting sections of the right tube that this condition was discovered.

The sections were made from the ampulla of the tube and presented the following appearance: The lumen of the tube presented the characteristic normal appearance, but was situated excentrically in the tube, the anterior wall being at least twice as thick as the posterior. The

FIG. 3



A portion of a cross-section of the tube at the ampulla. It represents the thickened anterior wall, containing a cross-section of the diverticulum from the lumen. It also shows how the layers of muscle may become blended together.

normal arrangement of the muscular layers was not observed, the entire wall being composed of fibres interlacing in all directions; otherwise it presented nothing abnormal.

In the thickened anterior muscular wall, somewhat below the level of the lumen and near the peritoneal covering, a small duct about one mm. in diameter was observed, separated from the lumen by a mass of muscular tissue about two mm. thick.

This "duct" presented the characteristic appearance of the tube, and was lined by a single layer of ciliated columnar epithelium, as represented in Fig. 4.

On cutting serial sections, it was found to communicate with the lumen of the tube, and was consequently a diverticulum from it. The diverticulum at its point of departure from the lumen of the tube was about two mm. in diameter. In its further course it was surrounded by a narrow layer of circular fibres, outside of which came the interlacing network of muscular tissue.

A glance at Fig. 4 will show that the diverticulum ran obliquely through the thickened anterior muscular wall, and for a certain distance constituted a canal distinct from the lumen of the tube.

How often similar formations occur I am unable to state, for I have only found them twice, and the only reference to them in the literature was made last year by Landau and Rheinstein,[1] who found a similar case.

They bear some resemblance to the accessory tubal ostia of Richard.[2] Rokitansky[3] and Klob,[4] but do not open on the surface as they do.

They also bear a marked resemblance to the sieve-like epithelial structures found in the tube in tubal pregnancies, as described by Werth.[5] As the tubes in my cases were not pregnant, we in all probability do not have to deal with the same formation, for I regard the structures mentioned by Werth as secondary to the changes produced by the tubal pregnancy.

Whether they be connected with these formations or not, I consider that they may hold a causal relation to tubal pregnancy. For what could be simpler than for the fertilized ovum to be driven by the action of the cilia into such a cul-de-sac, and to remain there and develop.

Such an origin would also explain the early rupture in these cases; for the ovum would only be separated from the peritoneal cavity by a thin layer of muscle, instead of the whole thickness of the tube wall.

In this opinion I am supported by a case of Landau and Rheinstein's:[6] In a six weeks' tubal pregnancy, and in which the woman died from hemorrhage, on cutting sections of the pregnant tube they found the embryo in the upper part of the tube close under the peritoneum; while in the lower part of the tube, and separated from the ovum by a thick mass of muscular tissue, they found the almost unchanged lumen of the tube. From this observation they concluded that the pregnancy

[1] Landau und Rheinstein: "Beiträge zur path. Anatomie der Tuben," Arch f. Gyn., Bd. xxxix, p. 273.

[2] Richard: "Pavill. multipliés, etc.," Gaz. Méd. de Paris, 1851, No. 26.

[3] Rokitansky: "Ueber accessorische Tubarostien und ueber Tubaranhänge," Allg. Wiener med. Zeitung, 1859, No. 32.

[4] Klob: Die path. Anatomie der weiblichen Sexualorgane, Wien, 1864. "Accessorische Tubarostien," p. 279.

[5] Werth: Beiträge zur Anatomie der Extra-uterinschwangerschaft, 1887.

[6] Loc. cit.

developed in a diverticulum from the lumen, similar to the one just described.

The proof is not absolute, but the facts are extremely suggestive.

Twistings of the Fallopian Tube.—I also desire to direct attention to a twisted condition of the tube, and will attempt to show that it may help to explain some conditions which were previously inexplicable.

Freund,[1] of Strasburg, and one of his pupils, Schober,[2] were the first to direct our attention to the significance of this condition, and my observations tend to substantiate their statements.

A peculiar and inexplicable fact in the development of the Fallopian tubes is that at an early period they undergo a process of twisting which begins at the uterine end of the tube and extends outward until at last the entire tube presents a corkscrew-like appearance.

What causes this twisting is absolutely unknown, unless we suppose it to be due to the resistance offered to its growth by the surrounding parts, as in the case of the sweat-glands.

In a fœtus of five months this process is quite marked (Fig. 5, *A*), and it gradually increases until the eighth month, when it has reached its highest development.

At this period it presents a corkscrew-like appearance with from six and a half to seven and a half twists, beginning at the uterine end. (Fig. 5, *B*.)

This condition I have noticed in several cases.

In the period between birth and puberty the tube is gradually untwisted, beginning at the uterine end and extending outward, until at puberty the twists have entirely disappeared or are only represented by a mild curve in the course of the tube.

This process is represented in Fig. 5, *C*, from a three-year-old child, and Fig. 5, *D*, which represents the normal tube at the time of puberty.

What significance this process may have in the development of the tube I am unable to state; though even during childhood it may become so marked as to cause the tube to be twisted apart, as has been observed by Rokitansky.

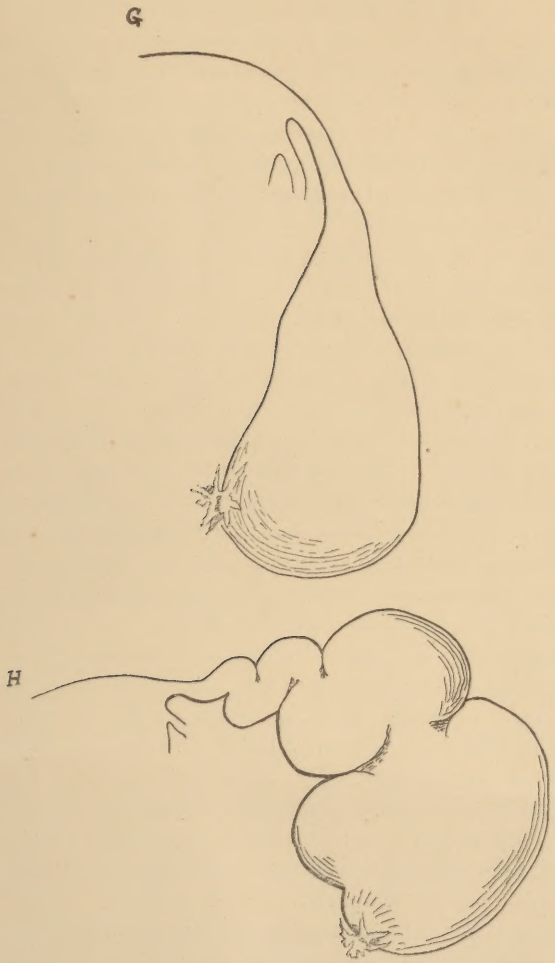
Owing to lack of development or some unknown cause, the twisted condition of the tube may persist throughout life. Most of the cases in which this has been noticed are in women who are poorly developed sexually.

It will be readily understood that such a condition in an adult woman may lead to serious consequences.

[1] Freund: "Ueber die Indicationen zur operativen Behandlung der erkranken Tuben," Volkmann's Sammlung klinischer Vorträge, 1888, No. 323.

[2] Paul Schober: "Ueber Erkrankungen gewundener Tuben." Inaug. Dissert., Strasburg, 1889.

FIG. 5.



A represents the tube of a five-months' fœtus, with the twisting well marked. *B*, the tube of an eight-months' fœtus with the twisted condition at its highest development. *C*, the tube of a three-year-old child, showing the gradual obliteration of the twists. *D*, the tube of a well-developed girl at puberty. *E* and *F*, the tubes of a sterile married woman, aged thirty-nine years, who was otherwise perfectly healthy. *G* represents a hydrosalpinx developed in a normally arranged tube, and *H* a hydrosalpinx developed in a twisted tube.

In the first place, one or more of the twists may be so marked as to cause a total occlusion of the lumen, just as one may do with a rubber tube. The consequence of such an occlusion would be that the woman would be sterile, for the ova could not pass beyond it on their passage to the uterus, nor the spermatozoa above it on their way to the ovary; and

if the condition were the same on both sides, the woman would be perfectly sterile. Fig. 5, *E* and *F*, represent both tubes from a sterile woman aged thirty-nine years, who was otherwise perfectly healthy.

A similar condition of the tube may cause retention of the normal secretions and so give rise to a hydrosalpinx, which may be lobulated or not, according to the number of twists by which the lumen is occluded. Fig. 5, *G*, represents a hydrosalpinx in a normal non-twisted tube, and Fig. 5, *H*, in a twisted tube.

I desire to record the following case of hydrosalpinx, which I believe was caused in this way. I will quote from my records—"January 26, 1891: Tube and ovary from left side. Tube converted into a lobulated hydrosalpinx, immensely distended, and wound around the ovary; 19 cm. long, 6 cm. in widest and ½ cm. in thinnest part. For a distance of 7 cm. from uterus the tube is apparently unchanged and about 5 mm. in diameter, then it suddenly expands into the lobulated hydrosalpinx, which was densely adherent to the ovary. The median end of the tube is perfectly pervious, but it is impossible to pass a fine probe from it into the hydrosalpinx, for it appears to pass into a cul-de-sac and go no further. On cutting open the dilated end of the tube and probing toward the uterus, on giving a slight twist the probe readily passed into the undilated part, thereby giving the impression that the constriction was caused by a twist in the tube."

This certainly appears to be a rational explanation for some cases of hydrosalpinx. In other cases the twisting may not totally occlude the tube, but only cause a narrowing of its lumen, and this also may lead to serious consequences.

If, for example, the tube becomes inflamed, the swelling of the mucous membrane may be sufficient to cause total occlusion or to so narrow the lumen that the secretions collect and greatly interfere with healing by preventing drainage of the parts.

If we have a purulent salpingitis, nothing is simpler than for the apposed surfaces of the twisted portion, which have lost their epithelium, to become adherent and thus produce a total and permanent occlusion and rapidly form a pus cavity. And according as one or more twists become imperforate, we get a more or less lobulated mass.

These twistings, of course, cannot be diagnosed during life, except in cases in which they lead to the formation of lobulated tumors, when the lobulated form will distinguish them from the more rounded or pear-shaped tumors, which develop from the normally shaped tube.

This abnormality, however, deserves consideration, for it may explain many cases of sterility, some cases of obstinate catarrhal salpingitis, and many cases of hydro- and pyosalpinx.

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